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(54) **Radar systems**

(57) A radar system has separately-located transmitting and receiving stations operating on a repetitive operating cycle. The transmitting station includes means (15) for generating a data message defining variable operating parameters of the system for a specified subsequent operating cycle. Modulating means (14) cause this data message to be modulated on to at least part of selected pulses transmitted by the transmitter (10). The receiving station includes a receiver or receivers, a demodulator for extracting the data message from a received pulse, and control means for causing the receiving station to operate during the operating cycle defined by a data message in accordance with the operating parameters defined by that data message.

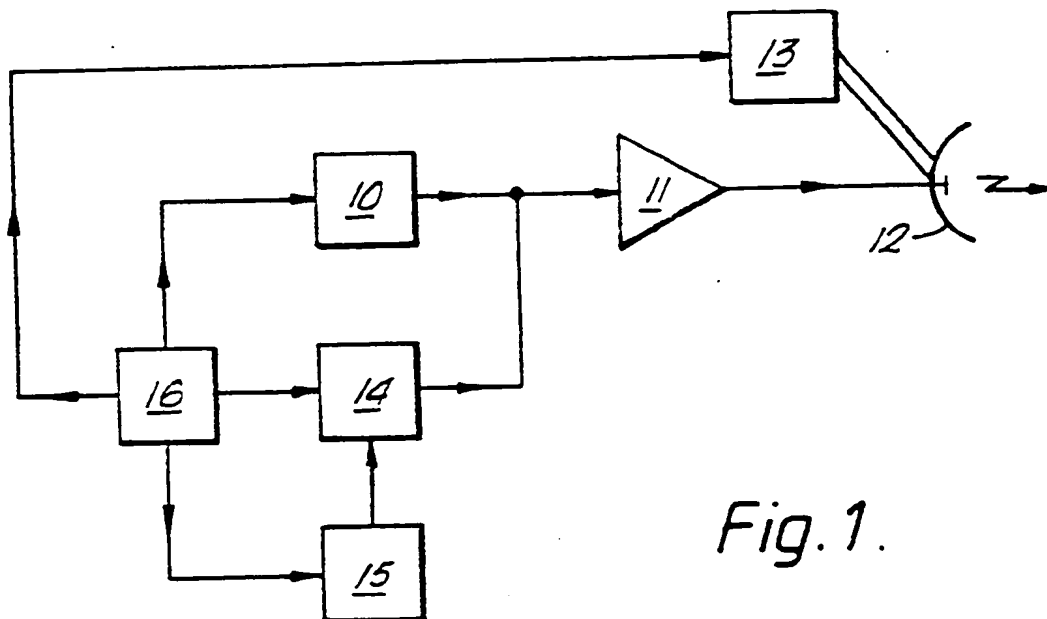


Fig. 1.

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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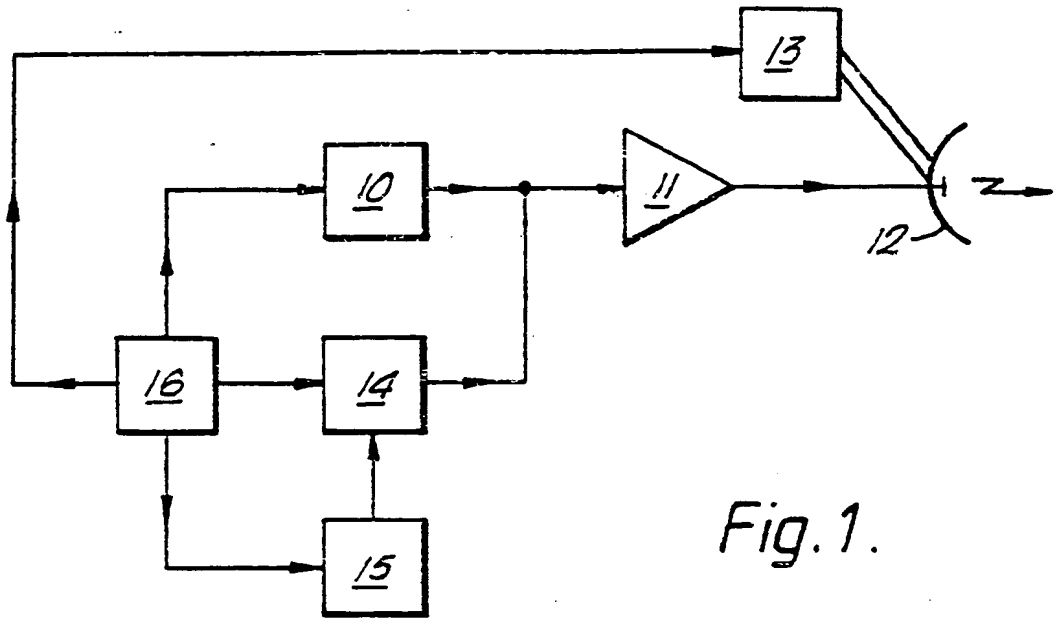


Fig. 1.

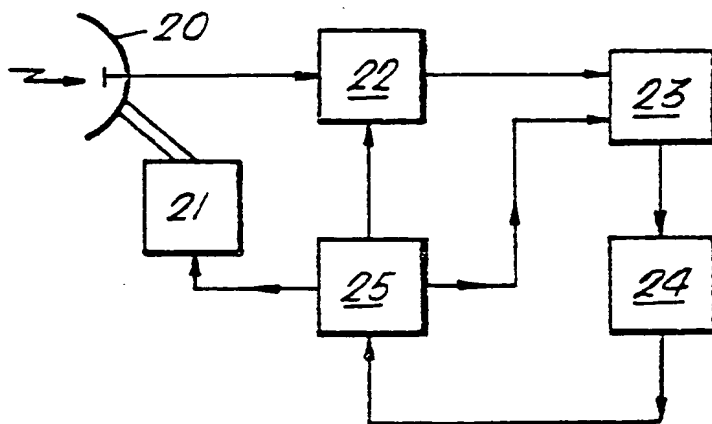


Fig. 2.

RADAR SYSTEMS

This invention relates to radar systems, and in particular to bistatic or multistatic systems.

Bistatic and multistatic radar systems require the use of transmitters and receivers at sites separated by a considerable distance. A bistatic system uses two such sites, one for the transmitter and one for the receiver. A multistatic system uses at least three sites and has several transmitters and/or receivers. Usually bistatic or multistatic systems are used to improve the resistance of the system to electronic counter measures.

If any of the operating parameters of the radar system are variable, such as mode or frequency, then it is necessary either for the equipment at the various sites to follow a rigid predetermined programme of changes, or to provide some form of communication channel between the sites. In the former case very accurate timing is necessary to maintain synchronisation, which may require the use of an atomic clock, and system operation will be inflexible. In the latter case the communication channel may be a cable or radio link if the sites are static, or may be a dedicated data link if movable sites are used. The latter, however, present problems in some situations, such as occur when the sites are aircraft. The extra equipment necessary increases the weight, cost and space requirement, and also required additional radio emissions which increase the vulnerability of the aircraft. In addition the links are liable to interception and/or jamming, since the power available will inevitably be low.

It is an object of the invention to provide a radar system having an improved data link between separately-located sites.

According to the present invention there is provided a radar system having a repetitive operating cycle, which includes at least one transmitting station comprising a transmitter operable to transmit pulses of radiations, circuit means operable to generate a data message defining variable operating parameters of the system for a specified subsequent operating

cycle, modulating means for modulating at least part of selected transmitted pulses with said data message, and a transmitting antenna movable under the control of a transmitting antenna control system; and at least one separately-located receiving station comprising a receiver operable to receive said transmitted pulses, demodulating means operable to extract said data message from the received pulse, a receiving antenna movable under the control of a receiving antenna control system, and control means responsive to the data message to control the operation of the receiving station during the operating cycle specified by the data message in accordance with the parameters defined by the data message.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 is a schematic block diagram of a transmitting station;

Figure 2 is a schematic block diagram of a receiving station;

Referring now to Figure 1 a transmitting station includes a master oscillator 10 and a power amplifier 11 together producing radar pulses for transmission from the antenna 12. Movement of the antenna is determined by an antenna control system 13 containing the necessary mechanical drives and pickoffs to move the antenna as required.

A pulse modulator 14 is provided which may be used during normal operation of the radar system to impose some required form of modulation on the signal generate by the master oscillator 10. A data message generator 15 is also provided which operates under the control of a processor 16 to generate a data message which defines the variable operating parameter to be used during a specified future operating cycle of the radar system. The variable factors may include the antenna scanning pattern, the frequency of operation, any coding to be used with the transmitted pulse, and perhaps the location of the transmitting station. The programmes defining changes in some or all of these factors are generated by the processor, which controls the operation of the master oscillator 10 and antenna

scanning unit 13 accordingly. The data message so produced may be encoded and is then applied to the pulse modulator 14 to be imposed on part or all of the transmitted radar pulse. The data message is transmitted during each pulse throughout one
5 operating cycle of the radar system, which would normally be one scanning cycle of the antenna. Hence by the end of an operating cycle the data message will have been transmitted in all directions covered by the antenna scan. Clearly the antenna scan should preferably include the location of the or
10 each associated receiving station, though it is very likely that the side lobes of the antenna 12 contain sufficient energy for the data message to reach a receiving station even if the main transmitted beam does not pass over the receiving station. By way of example only, a data message may contain between 200 and
15 300 bits, and may be carried by a 15 microsecond pulse using frequency shift keying at 20MHz.

Figure 2 is a schematic diagram of an associated receiving station in the bistatic or multistatic radar system. A receiving antenna 20 has its movements controlled by an
20 antenna control system 21, and applies signals to the receiver 22 and demodulator and detector 23. The output from the demodulator and detector 23 is applied to a decoder 24 which extracts the data message contained in the received signal. The data message is passed to a processor 25 which controls the
25 operation of the antenna control system 21, receiver 22 and demodulator and detector 23 in accordance with the contents of a previously-received data message. As an alternative to using the existing receiving antenna and receiver, a separate antenna and receiver may be provided specifically for receiving the data
30 transmissions.

The system described above has a number of advantages over the dedicated data link which would otherwise be necessary if one or more of the stations was mobile. Very little additional equipment, if any, is necessary to enable the data to
35 be transmitted and received. In addition the possibility of the data message being recognised as such and hence being intercepted is slight, and there will be few or no recognisable

features to the transmitted radar signal. Of considerable importance also is the fact that normal radar power levels and antenna systems are used, making jamming of the signals more difficult.

5 The system is also clearly more flexible than one using a predetermined programme of operating parameters. However, the present system may be provided with such a programme for use if the data messages are interrupted.

10 Details of the normal radar transmitters and receivers given above are intended only to be general in concept and any of the acceptable variations in circuitry made necessary by different operating modes may be applied.

What we claim is:-

1. A radar system having a repetitive operating cycle, which includes at least one transmitting station comprising a transmitter operable to transmit pulses of radiation, circuit
5 means operable to generate a data message defining variable operating parameters of the system for a specified subsequent operating cycle, modulating means for modulating at least part of selected transmitted pulses with said data messages, and a transmitting antenna movable under the control of a transmitting
10 antenna control system; and at least one separately-located receiving station comprising a receiver operable to receive said transmitted pulses, demodulating means operable to extract said data message from the received pulse, a receiving antenna movable under the control of a receiving antenna control system,
15 and control means responsive to the data message to control the operation of the receiving station during the operating cycle specified by the data message in accordance with the parameters defined by the data message.
2. A system as claimed in Claim 1 in which the receiving
20 station receives the transmitted pulses directly from the transmitting antenna.
3. A system as claimed in Claim 1 in which the receiving station receives the transmitted pulses by reflection from a target.
- 25 4. A system as claimed in any one of Claims 1 to 3 in which the control means of the receiving station includes a processor responsive to the data message to control the operation of the receiver, the demodulating means and the receiving antenna control system.
- 30 5. A system as claimed in any one of Claim 1 to 4 in which the circuit means of the transmitting station includes a processor operable to control the operation of the transmitter, the modulating means and the transmitting antenna control system during an operating cycle in accordance with the data word
35 relating to that cycle.
6. A radar system as claimed in any one of the preceding claims in which each transmitted pulse is modulated with the data message.

7. A system as claimed in any one of Claims 1 to 6 which includes a single transmitting station and a single receiving station.

8. A radar system substantially as herein described with
5 reference to the accompanying drawings.

AMMENDMENTS TO THE CLAIMS HAVE BEEN FILED AS BELOW

1. A radar system having a repetitive operating cycle, which includes at least one transmitting station comprising a transmitter operable to transmit radar pulses of radiation,
5 circuit means operable to generate a data message defining variable operating parameters of the system for a specified subsequent operating cycle, modulating means for modulating at least part of selected transmitted radar pulses with said data message, and a transmitting antenna movable under the control of
10 a transmitting antenna control system; and at least one separately-located receiving station comprising a receiver operable to receive said transmitted radar pulses, demodulating means operable to extract said data message from the received radar pulses, a receiving antenna movable under the control of a
15 receiving antenna control system, and control means responsive to the data message to control the operation of the receiving station during the operating cycle specified by the data message in accordance with the parameters defined by the data message.

2. A system as claimed in Claim 1 in which the receiving
20 station receives the transmitted ^{radar} pulses directly from the transmitting antenna.

3. A system as claimed in Claim 1 in which the receiving station receives the transmitted radar pulses by reflection from a target.

25 4. A system as claimed in any one of Claims 1 to 3 in which the control means of the receiving station includes a processor responsive to the data message to control the operation of the receiver, the demodulating means and the receiving antenna control system.

30 5. A system as claimed in any one of Claim 1 to 4 in which the circuit means of the transmitting station includes a processor operable to control the operation of the transmitter, the modulating means and the transmitting antenna control system during an operating cycle in accordance with the data word
35 relating to that cycle.

6. A radar system as claimed in any one of the preceding claims in which each transmitted radar pulse is modulated with the data message.

7. A system as claimed in any one of Claims 1 to 6 which includes a single transmitting station and a single receiving station.

8. A radar system substantially as herein described with
5 reference to the accompanying drawings.